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CVC SiC Mirrors for High Energy Laser Applications (Preprint)

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14. ABSTRACT
A series of lightweighted CVC SiC mirror structures were evaluated for characteristic frequency. The lightest structure considered (areal density = 4.7 kg/m2) had a first harmonic mode > 3500 Hz. Under a thermal load of 100 W m-2, the surface distortion was less than 1/10.

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CVC SiC Mirrors for High Energy Laser Applications

Trex Enterprises Corporation
Lihue, Hawaii

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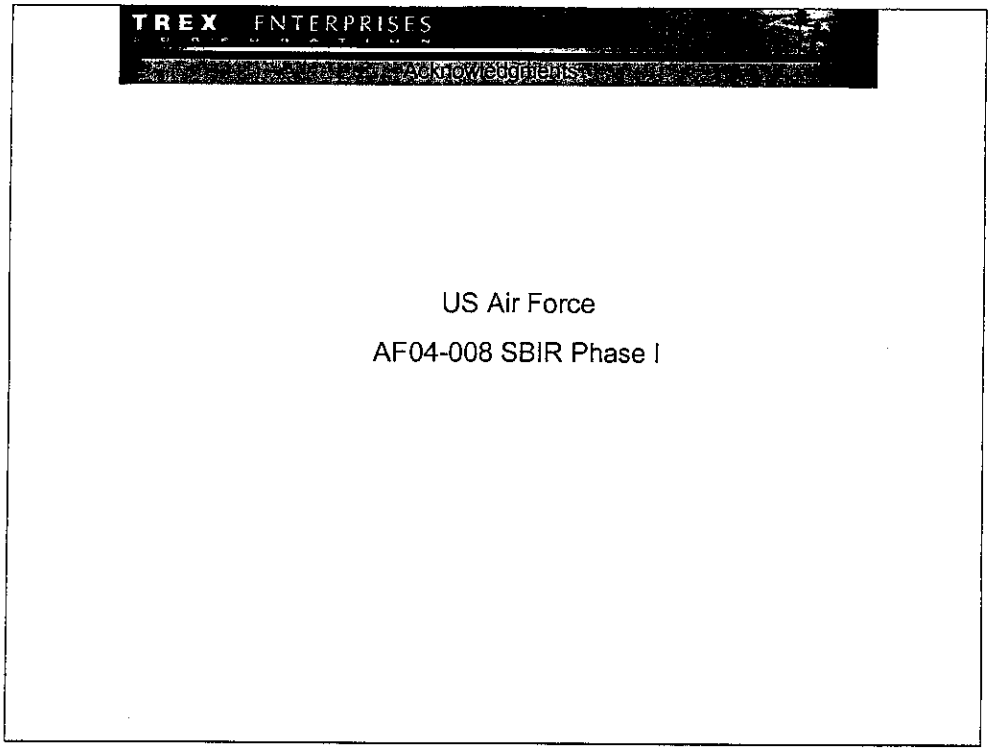
In another SBIR effort, we were interested in the mechanical and thermal stability of mirrors fabricated from CVC SiC.



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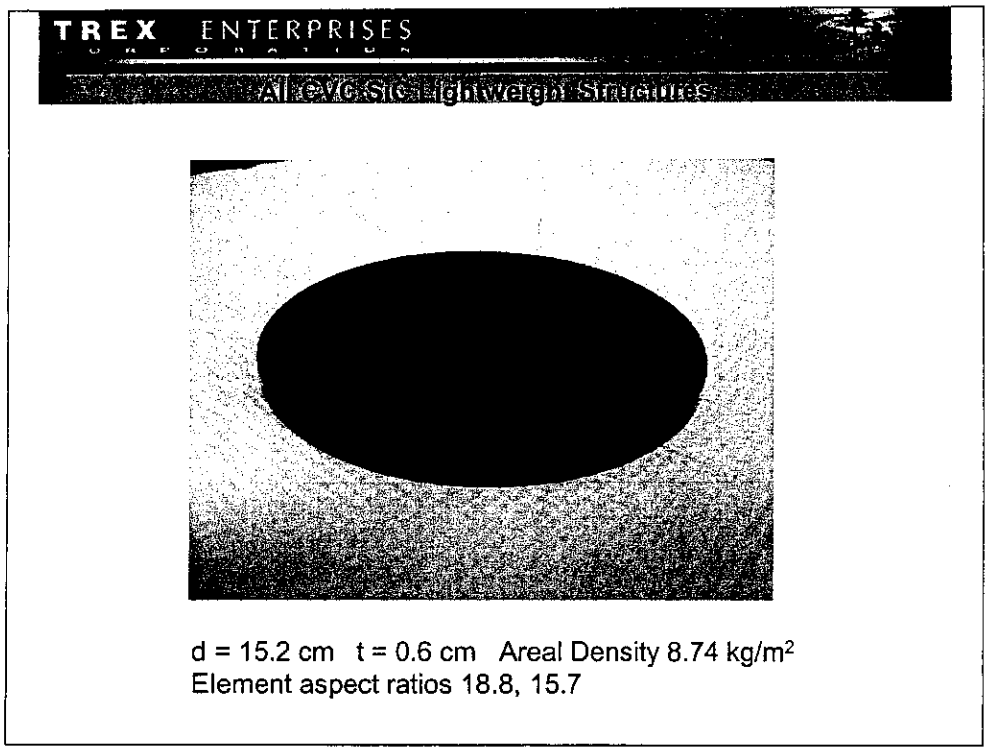
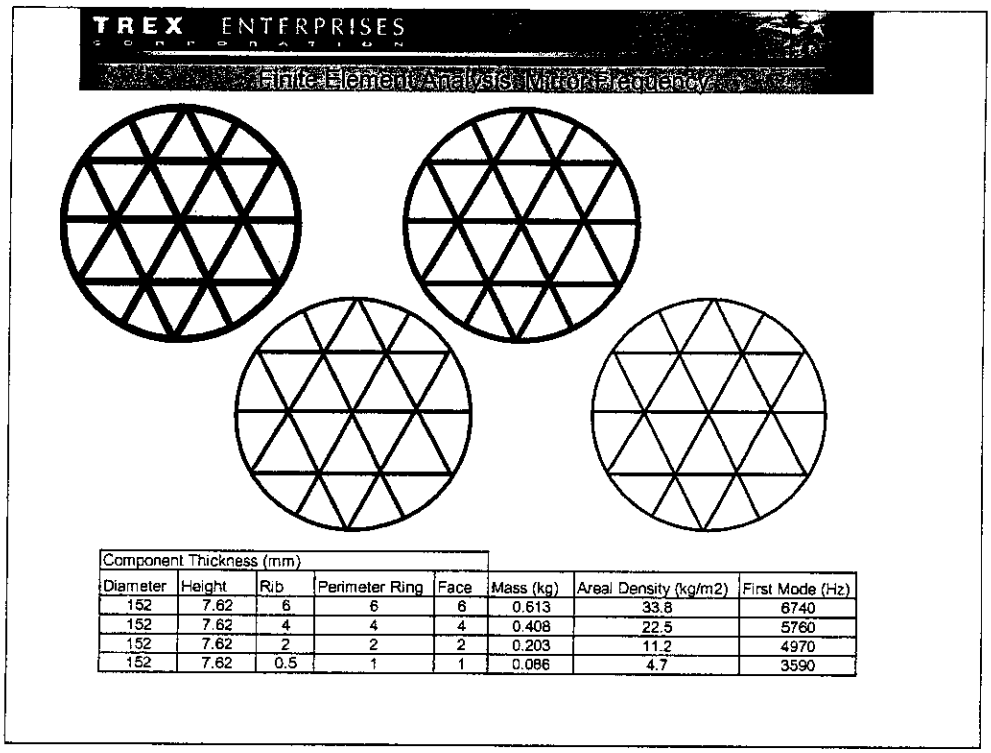


In order to reduce areal density, CVC SiC material can be removed via machining, even if for designs where the facesheet and rib walls are very thin. **This figure** shows a 15.2 cm diameter, 0.60 cm thick CVC SiC disc that has had material removed via machining. The facesheet and rib thickness are 0.15 cm. The 12 full triangular rib elements have effective aspect ratios of 19. THe partial triangle elements at the perimeter have aspect ratios of 16. The total mass and areal density are 0.163 kg and 8.98 kg/m2, respectively. The machining of the rib backing structure removed approximately 53% of the total mass.



Component Thickness (mm)							
Diameter	Height	Rib	Perimeter Ring	Face	Mass (kg)	Areal Density (kg/m2)	First Mode (Hz)
152	7.62	6	6	6	0.613	33.8	6740
152	7.62	4	4	4	0.408	22.5	5760
152	7.62	2	2	2	0.203	11.2	4970
152	7.62	0.5	1	1	0.086	4.7	3590

The basic lighweight mirror structure was evaluated for fundamental and higher harmonic frequencies using finite element analysis. This task was executed by ATA Engineering. For the frequency analysis, four different structures were considered. All had a diameter of 152 mm and thickness of 7.62 mm. What was varied were the thicknesses of the various components, the facesheet, the ribs, and the perimeter ring.

You can see that as the component thickness is reduced, the areal density also decreases, as does the first harmonic mode of the part.

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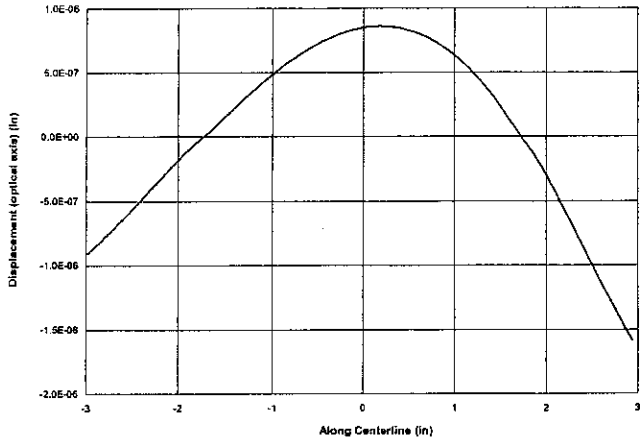
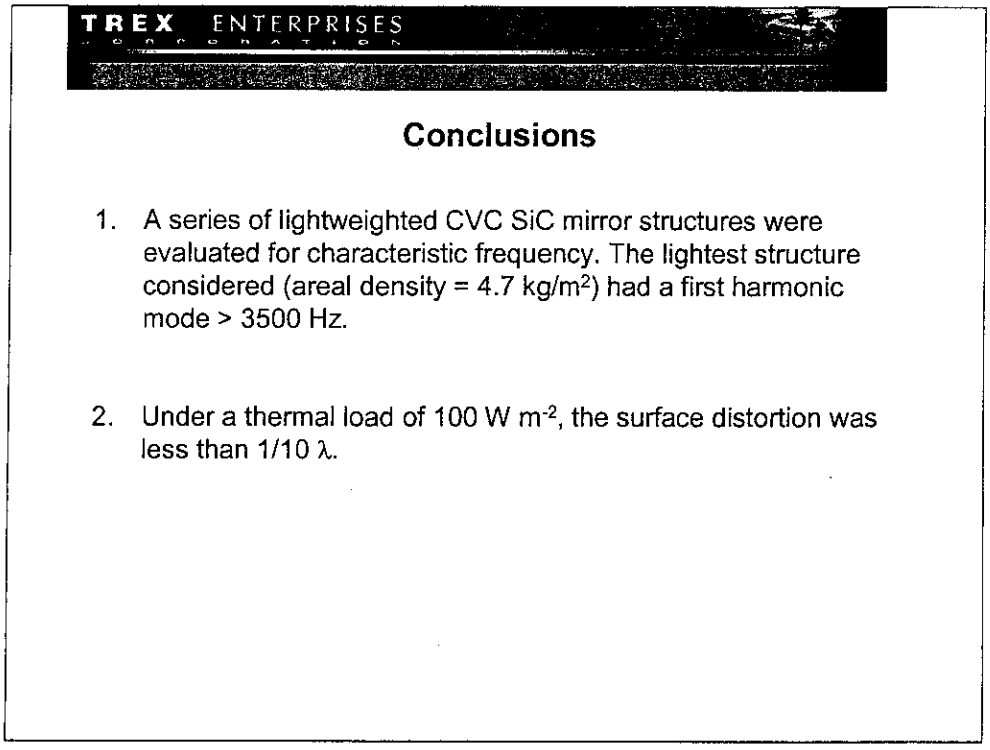
Finite Element Analysis: Steady State Thermal Response with 100 W m^{-2} Heat Load Off-Center.



ATA Engineering also considered the situation where the mirror was exposed to a heat source. This plot shows the mirror distortion across a trace through the center of the structure. The heat load was 100 W/m^2. The asymmetric curve is due to the incident light impinging on the mirror somewhat off center. In any case the total distortion was 62.4 nm P-V, or less that 1/10 λ for a He-Ne based metrology.



Above points will be paraphrased in the presentation.